

**SOME INSECTS OTHER THAN BEES ASSOCIATED WITH
LARREA TRIDENTATA IN THE SOUTHWESTERN UNITED STATES**

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ABSTRACT—This study reports the results of a preliminary investigation of some insects other than bees associated with the creosote bush, *Larrea tridentata*, in the southwestern United States.

Like many plants with chemical and physical properties which reduce predation by vertebrate and invertebrate herbivores in general, the creosote bush (*Larrea tridentata* (De Candolle) Coville, Zygophyllaceae) has its own constellation of insects which have evolved a tolerance for its leaves, stems, roots and flowers. While carrying out field studies of the desert bees involved in the pollination of this plant in New Mexico, Arizona and southern California (Hurd and Linsley, 1975), it was inevitable that we encountered many of these insects. No attempt was made to conduct a survey of *Larrea* insects, a project which would no doubt prove to be rewarding. However, samples were taken and observations were made on a few of the more conspicuous or ubiquitous insects, especially those which offered competition to bees for pollen or nectar, or were large enough to disturb the activities of the bees, or those which utilized the plant as a haven for predation on bees and other insect visitors.

While theoretically it is possible that every species of insect which occurs where *Larrea* grows could ultimately be found on this plant, it is evident that such exceptional visitations for whatever purpose are of little or no evolutionary significance.

References to *Larrea* insects have been cited where known to us, but a thorough survey of the literature was not undertaken in view of the preliminary nature of this report.

Descriptions of the procedures and the principal sampling and survey sites from which most of the records referred to here were obtained may be found in Hurd and Linsley (1975).

There has been lack of agreement among botanists as to the appropriate name for the species of *Larrea* inhabiting North America, some regarding it as conspecific with the South American *Larrea divaricata* Cav., others as a distinct species, *L. tridentata*. We follow Porter (1963, 1974) and Raven (1963) in utilizing the designation *Larrea tridentata*.

ACKNOWLEDGMENTS

This is one of a series of studies being conducted by a group of museum and university investigators called the "Origin and Structure of Ecosystems, Integrated Research Program (IBP)." The immediate objective of this program is to determine the structural and functional similarity of ecosystems that have evolved separately but under similar climatic regimes, and which are largely or entirely formed by species with different phylogenetic histories. The present study forms an integral part of the Desert Scrub Project (Solbrig, 1972) of central and northern Argentina and northern Mexico and the southwestern United States.

We gratefully acknowledge the support of our part of this project by the National Science Foundation (GB-31191), the Smithsonian Research Foundation (SRF-430039), and the Leopold Edward Wrasse and Elvenia J. Slosson Endowment Funds of the Division of Agricultural Sciences, University of California.

Appreciation is expressed to Mrs. E. G. Linsley, Prof. and Mrs. A. E. Michelbacher, Mont A. Cazier, and Marjorie Statham Favreau for assisting in field studies of *Larrea*-visiting bees during which insects other than bees were also sampled.

Identifications by the staff of Systematic Entomology Laboratory, U.S.D.A., were most helpfully provided in certain groups of Coleoptera by R. D. Gordon, J. M. Kingsolver, T. J. Spilman, R. E. Warner and R. E. White; of Diptera by R. J. Gagné, L. V. Knutson, G. C. Steyskal, C. W. Sabrosky, and F. C. Thompson; of Hymenoptera by A. S. Menke; and of Hemiptera by J. L. Herring and J. P. Kramer. Those of Lepidoptera were kindly furnished by J. F. G. Clarke and D. R. Davis of the Department of Entomology, Smithsonian Institution, and by J. A. Powell of the Department of Entomological Sciences, University of California, Berkeley.

Sigurd L. Szerlip kindly made available a preliminary report on some *Larrea* insects which he prepared as a course requirement at Arizona State University.

In the discussions that follow, the species are arranged by family which in turn are arrayed by order in general phylogenetic sequence. As will be noted the orders Orthoptera and Hemiptera are treated for convenience of presentation in the broad, and hence more inclusive, sense.

ORTHOPTERA

Three families of this order contain a number of species which have evolved some dependence on *Larrea* in the southwestern United States and adjacent Mexico.

ACRIDIDAE

Among the acridids, the creosote grasshopper, *Boottettix punctatus* Scudder, is perhaps the most widely distributed of the grasshoppers associated with *Larrea*. Although we have encountered it mainly in southern Arizona and southeastern California, it is reported to occur throughout the range of its host plant (Barnum, 1964) and its known occurrence in California has been recorded and mapped by Strohecker, Middlekauff and Rentz (1968). As emphasized by Ball (1936) and Ball et al. (1942), the coloration of this species is re-

markably similar to that of the creosote bush katydid and, like that species, it is difficult to see in the foliage.

Another widespread and ubiquitous *Larrea* grasshopper is the desert clicker, *Ligurotettix coquilletti* McNeill. Rehn (1923) has given a good account of its habits, recognizing three subspecies, as do Strohecker, Middlekauff, and Rentz (1968). The form most commonly encountered by us during our sampling program in southern Arizona, Sonora and New Mexico, we interpret as *L. coquilletti kunzei* Caudell. Although this species is generally regarded as more or less restricted to *Larrea*, some of the populations apparently exceed the range of this plant and presumably overlap onto other hosts. Although of a different cryptic coloration than *Boottettix tenellus*, being grayish and brown, *Ligurotettix* is nevertheless difficult to locate, even when the presence of the males is clearly announced by their characteristic stridulation.

Another species of grasshopper considered by Ball et al. (1942) as confined to *Larrea* in parts of Arizona, Sonora and the Chihuahu Desert of Mexico, *Clematodes larreae* Scudder, has not been seen in the field by us. It is also said to be mottled grey and brown, similar to the stems of the plants.

In the vicinity of Portal, Cochise County, Arizona, we have frequently collected *Conalcea huachucana* Rehn, a brownish or grayish-brown species with small oval whitish wingpads and a dark brownish black lateral stripe on the thorax. The species, inconspicuous on the *Larrea* plants, frequently turns up in the net along with a deliberately collected bee sample.

A widespread acridid, appearing casually on *Larrea*, is *Schistocerca vaga* (Scudder), which prefers other habitats but is not uncommon on this plant in the summer and fall near Lake Cienega, Hidalgo County, New Mexico.

The only katydid regularly encountered by us in southeastern Arizona and western New Mexico has been the creosote bush katydid, *Insara covilleae* Rehn and Hebard. The nymphs and adults are so cryptically colored that they are difficult to discern among the *Larrea* foliage. Most of our examples turned up in the net as a "bonus" when we were capturing a bee. Rehn and Hebard (1914) have given an account of the behavior and coloration of this remarkable insect and their observations and distributional data have been supplemented by Ball et al. (1942) and Barnum (1964).

PHASMIDAE

Phasmids are not uncommon on *Larrea* but like so many inhabitants of this plant they are cryptically colored and difficult to discern. In southern Arizona and western New Mexico, the species most frequently encountered were *Diapharomera covilleae* Rehn and Hebard,

the creosote bush walking stick, and *D. arizonensis* Caudell. In the San Simon Valley, and southeastern Arizona and adjacent New Mexico, where much of our bee sampling was done, *D. covilleae*, the larger of the two, with the female brown and gray, was the less common. *Pseudosermyle straminea* Scudder, a gray species, was also found on *Larrea* in the San Simon Valley.

MANTIDAE

Mantids, especially *Stagmomantis limbata* (Hahn) are common on *Larrea* in southern Arizona and New Mexico. This species is very cryptically colored and can often be located most readily by the prey which it holds. We have observed females capturing bees and wasps as they visit the flowers of *Larrea* in the summer and fall, including males of the large carpenter bee, *Xylocopa californica arizonensis* Cresson, feeding first on the muscles of the thorax.

HEMIPTERA

While our investigations have revealed the varying dependence on *Larrea* of a comparatively large number of species belonging to 11 families of this order, there are doubtless additional species which will be found to derive a significant part of their economy from or in association with *Larrea* in the southwestern United States and adjacent Mexico.

MIRIDAE

The most abundant of the mirids encountered on *Larrea*, particularly in southern Arizona and New Mexico, were the cryptic brown to greenish *Phytocoris*. Sweeping the plants at several of our sites would no doubt have yielded thousands of specimens. Several species were involved, mostly taken in May and June. Knight (1925) described *Phytocoris covilleae* from *Covillea* (= *Larrea*) at Tucson, Arizona, and subsequently recorded *P. nigripubescens* Knight from *Larrea* in Nevada (Knight, 1968). In the collection of the California Insect Survey, University of California, Berkeley, there is a long series of this last species from Hopkins Well, Riverside County, California, collected from *Larrea* on April 16, 1958 by Dr. Jerry Powell (det. J. C. M. Carvalho).

Other mirids found on *Larrea* from time to time were *Neurocolpus nubilis* (Say), *Oncerometopus nigriclavus* Reuter, *Lygus desertinus* Knight, *L. lineolaris* (Palisot de Beauvois), *Rhinacloa forticornis* Reuter, and *Parthenicus covilleae* Van Duzee. This last species has been recorded from *Larrea* (or *Covillea*) at Palm Springs, Riverside County, California (Van Duzee, 1918), Guadalupe Point and Carmen Island, Baja California (Van Duzee, 1923, as *P. percroceus*), the Nevada Test Site, Nevada, Tucson, Arizona, and Fabens, Texas

(Knight, 1968). Knight (loc. cit.) states that "it now appears from material examined that *Parthenicus covilleae* Van D. is found on *Larrea divaricata* [= *tridentata*] over the range of this plant in Arizona, southern California and Nevada."

REDUVIIDAE

As would be expected, predaceous bugs of the family Reduviidae utilize *Larrea* foliage and flowers as a source for their prey. The most abundant and widespread of these in our experience is *Zelus socius* Uhler, which we encountered frequently from southern California to New Mexico. *Sinea complexa* Caudell and *Apiomerus flaviventris* Herrich-Schaeffer were also taken occasionally. The latter was observed feeding on solitary bees among the blossoms of *Baccharis glutinosa* and *Prosopis juliflora* as well as those of *Larrea*. Coquillett (1892) has reported adults and nymphs of this species preying on honeybees in southern California.

LYGAEIDAE

Our limited samples did not yield many lygaeids, only *Xyonysius californicus* (Stål) and *Nysius raphanus* Howard, which were no doubt casual visitors to *Larrea*.

PYRRHOCORIDAE

Individual specimens of the ubiquitous *Largus cinctus* Herrich-Schaeffer were found on *Larrea* from time to time, especially near Tucson, Pima County, Arizona in the spring and summer.

COREIDAE

Mozena arizonensis Ruckes was found occasionally on *Larrea* plants near Tucson, Pima County, Arizona, and Douglas and Portal, Cochise County, Arizona in both spring and summer. In one instance a robberfly, *Promachus giganteus* Hine had captured and was feeding on an individual from *Larrea*. We have also found this coreid on mesquite (*Prosopis juliflora* (Swartz) DeCandolle).

The widespread ubiquitous *Liorhyssus hyalinus* (Fabricius) was found on *Larrea* at Portal and Douglas, Cochise County, Arizona, in May.

PENTATOMIDAE

The most commonly encountered pentatomid on *Larrea* was the cryptic, brown *Dendrocoris contaminatus* Uhler. We have taken it at Palm Springs, Riverside County, California and other Colorado Desert localities in April and May, at Tucson, Pima County, Arizona in May,

at Tombstone, Douglas and Portal, Cochise County in the spring and fall, at Granite Pass and Lake Cienega, Hidalgo County, New Mexico, in August, at Deming, Luna County and Las Cruces, Dona Ana County, New Mexico, also in August, and at various other localities in the southwestern desert area.

Another pentatomid commonly found on *Larrea* in southern Arizona and New Mexico was the green *Thyanta perditor* (Fabricius). This is a widely distributed Neotropical species and was observed on a variety of other plants.

More casual *Larrea* visitors included *Chlorochroa ligata* (Say) and a species of *Brochymena*.

MEMBRACIDAE

The membracid most frequently encountered by us on *Larrea* plants was *Centrodontus atlas* (Goding). It was abundant in May and June at several localities in Cochise County, Arizona, including Portal, Douglas, Tombstone and Naco.

CIXIIDAE

Oecleis campestris Fall was found on *Larrea* plants in May at Granite Pass, Hidalgo County, New Mexico.

FLATIDAE

Flatids of the genus *Ormenis*, including *O. saucia* Van Duzee, were taken on *Larrea*, sometimes in fairly large numbers, in May and August, at Portal and Douglas, Cochise County, Arizona.

ISSIDAE

Hysteropterum sepulchralis Ball was occasionally taken on *Larrea* at Portal and Douglas, Cochise County, Arizona, in May.

COCCIDAE

Among the scale insects associated with *Larrea*, the best known species is the creosote bush lac scale, *Tachardiella larreae* (Comstock). Ferris (1919b) summarized the knowledge of the species then extant, including its potential as a producer of commercial lac. Chamberlin (1923) treated it taxonomically. We have encountered this insect at various localities, especially in western Arizona, Sonora and southern California, where it is particularly abundant in the lower Colorado River drainage. Essig (1958) describes the general appearance of an infestation and illustrates infested twigs.

Several diaspidids have been recorded from *Larrea* in the southwestern United States. *Chrysomphalus covilleae* Ferris (1919a) was described

from Mormon Flat, east of Phoenix, Arizona where it was found on the bark and in cracks on exposed roots of *Larrea*. Ferris (1938) later synonymized it with *Targionia yuccarum* (Cockerell), a desert species ranging from Texas to Arizona, Baja California and Colima, Mexico, where it is found on a variety of plants, mostly Compositae. Cockerell (1897) described *Pseudodiaspis larreae* from Yuma, Arizona, where the females were said to be abundant on the stems of the host plant. Although Ferris (1921, 1938) subsequently referred to the species, he apparently based these citations on his previously reported collections. A third species, *Clavaspis covilleae* (Ferris), described initially in the genus *Aspidiotis* (Ferris, 1919a), was also collected originally at Mormon Flat, Arizona, beneath loose bark on exposed roots.

In addition to the above, Cockerell (1895) described the margarodid *Icerya (Proticerya) rileyi* from Las Cruces, New Mexico, reporting it as common on mesquite (*Prosopis*) and rather rare on creosote bush (*Larrea*). It is a widespread species and has been recorded from *Prosopis* in Arizona (Ferris, 1919a) and Baja California (Ferris, 1921) as well as from other plants. In 1902, Cockerell separated the *Larrea* form from the *Prosopis* form under the name *Icerya rileyi* var *larrae* (sic!) from Chihuahua, Mexico, a fact apparently overlooked by Ferris.

Finally, a dactylopiine, *Eriococcus larreae*, was described by Cockerell and Parrott (1899) from New Mexico where it was found on the crowns of *Larrea tridentata* underground, and a mealybug, *Spilococcus larreae* Ferris, appears to be regularly associated with *Larrea* in California and Arizona (Ferris, 1950; McKenzie, 1956) and we have encountered it on several occasions.

Although we have made no attempt to evaluate the status of the species involved, it is interesting to note that Leonardi (1911) described five species of coccids from Cacheuta, Argentina: *Birchippia americana* n. sp. from *L. divaricata* and *L. cuneata*, *Eriococcus diverspinus* n. sp. from *L. divaricata* and *L. cuneata*, *Ceroplastes irregularis* n. sp. from *L. cuneata*, *Eulecanium elegans* n. sp. from *L. cuneata* and *L. divaricata*, and *Protargionia* (n. gen.) *larreae* n. sp. from *Larrea divaricata* and *L. cuneata*.

COLEOPTERA

Although there are a number of species of this order occasionally encountered on *Larrea* on either the flowers or the vegetative parts of the plant, a relatively large number of species belonging to the following 6 families are known to depend to some extent upon this plant for their survival.

CLERIDAE

The only clerid taken in numbers on *Larrea* was *Phyllobaenus arizonica* Schaeffer. It was found in the spring at Naco, Tombstone, Douglas and Portal, Cochise County, Arizona and Granite Pass, Hidalgo County, New Mexico.

BUPRESTIDAE

The most conspicuous buprestids visiting *Larrea* flowers belong to the genus *Hippomelas*. The most abundant species encountered by us was the large, yellow-pollinose *H. planicosta* (LeConte), especially in southeastern Arizona and New Mexico during the summer-fall blooming period. In southern California it has been taken in June and July on *Larrea* when the plants are not in bloom and thus they are believed to be the larval host. During this off-season, J. W. MacSwain took long series from *Atriplex* at Blythe, Riverside County, California. In the San Simon Valley of Arizona and New Mexico, *H. sphenica* LeConte, a species ordinarily associated with mesquite (*Prosopis juliflora*), also feeds occasionally at *Larrea* flowers.

Acmaeodera cribricollis, originally described from Texas by Horn, (1894), was first recorded from *Larrea* as *Acmaeodera larreae* by Fall (1907), based upon three specimens from Mojave, California. Subsequently, Burke (1918) reported that the species mines heartwood of dying and dead stems of the creosote bush in Arizona. Adults were taken from the wood in January (also reported as *A. larreae*). Van Dyke (1917) recorded it from Imperial County, California without host data but the area is within the *Larrea* zone. In California, we have taken it in April on *Larrea* at a site 18 miles west of Blythe, Riverside County, at Palm Springs, Riverside County, and Borrego, San Diego County. In Arizona, we have taken numerous specimens on *Larrea* 18 miles west of Tucson in June and less abundantly in the San Simon Valley of Arizona and New Mexico in June and again in August. Adults generally fly in the heat of the day, although our Tucson examples span the period from 0800 at 25° C to 1900 at 32° C with the midday temperatures at 36° C. They fly like some bees and wasps and are cryptically colored, blending well with the *Larrea*. The ground color is brown with variable yellow-brown markings, unlike most other species of the genus. Although they feed at the flowers of *Larrea* when the plants are in bloom, they also feed at other plants after the flowering period, at least in southern California. Species of *Acmaeodera* known to be regularly associated with other hosts, occasionally visit *Larrea* flowers but we have not found any of these in significant numbers.

In the genus *Chrysobothris*, a single specimen of the uncommon *C. humilis* Horn was taken on *Larrea* at Douglas, Cochise County, Arizona, on May 20, 1973.

MELOIDAE

Among the numerous beetles associated with *Larrea*, meloids are perhaps the most commonly encountered. Of these, two are particularly striking, *Pyrota postica* LeConte, and *Eupompha fissiceps* LeConte. The former, like other members of the genus, is gregarious (Selander, 1964) and we have seen aggregations of many hundreds of individuals on its favored plant, the creosote bush, in several localities in southeastern Arizona, especially near Douglas and Portal in Cochise County, and in western New Mexico, where they appear to be associated with the Chihuahuan Desert *Larrea* formation. The beetles are large (15–18 mm) with the integument shining and yellow orange and the elytra yellow with black spots. The male is beautifully illustrated by Selander (1964, fig. 26) and also adorns the cover of the January/February issue of *The Insect World Digest* in full color (photograph by Tschinkel). Although *P. postica* are aposomatically colored and are conspicuous in large aggregations, individual specimens are difficult to see among the stems and foliage of *Larrea*. Although individuals of a related but very dissimilar species, *Pyrota akhurstiana* Horn were found on *Larrea* plants at several localities, no aggregations were observed, and it was not determined whether or not they were feeding.

Eupompha fissiceps, on the other hand, although as large or larger than *Pyrota postica*, has the head and appendages reddish and the elytra shining, rugose, and green, blue-green or blue. We have found it in much the same sites as *Pyrota postica*, most commonly in small numbers (e.g., Lake Cienega and Portal in the San Simon Valley, Douglas, Cochise County) but on one occasion, hundreds of individuals were encountered flying about *Larrea* along the edge of a highway north of Deming, New Mexico. Large numbers were mating, others feeding on the flowers. It was almost impossible to capture a bee without obtaining one or more of these in the net. When present in small numbers the insects are very inconspicuous, as commented upon by Werner, Enns and Parker (1966), the green body blending with the foliage and the head with the blossoms.

A second species presently assigned to *Eupompha*, formerly known as *Calospasta elegans* LeConte, is usually found on desert spring ephemerals, particularly Compositae, but we have taken it on flowers of *Larrea* near Yuma, Arizona. Werner, Enns and Parker (1966) report it as most frequent on *Sphaeralcea*, but also include *Larrea* among their flower records.

Species of *Epicauta* are often found on *Larrea* but in our experience, rarely in numbers. At Tombstone, *E. pardalis* LeConte, an insect that we have usually seen on mesquite, was found on *Larrea* plants that were just coming into bloom. Werner, Enns and Parker (1966) record the species from *Prosopis* and *Solanum*. Individuals of *E. lauta* Horn

were found on *Larrea* at several localities in southern Arizona and *E. nigratarsis* (LeConte) in New Mexico. Since most of the desert *Epicauta* appear to be associated with Solanaceae, especially *Solanum elaeagnifolium* Cav. or low growing plants like *Kallstroemia grandiflora* (Torrey) Gray, the flowers of which they often severely damage, their presence on *Larrea* is probably fortuitous but is worthy of further study.

The large, ponderous, flightless *Cysteodemus armatus* LeConte are often found on *Larrea* plants growing within their range. In March we encountered hundreds of individuals feeding on *Larrea* at a site just north of Yuma, Arizona.

Because of the large number of bees that visit *Larrea*, it is not surprising that this is a common host for nemognathine meloid parasites. Among the species most commonly encountered by us in Arizona and New Mexico were *Nemognatha nitidula* Enns and *N. meropa* Enns and in the Colorado and Mojave Deserts of California, *N. macswaini* Enns (1956). These last two are also recorded from *Larrea* by Werner, Enns and Parker (1966). The type series of *N. macswaini*, and also of *Pseudozonitis vauriae* Enns, included specimens from *Larrea*, and we have taken the latter from flowers of this host just north of Portal, Cochise County, Arizona and at Lake Cienega, Hidalgo County, New Mexico.

TENEBRIONIDAE

A single example of the unusual tenebrionid *Eupsophulus castaneus* (Horn) (det. John T. Doyen) was taken on *Larrea* flowers at Tucson, Pima County, Arizona, 6 August 1973.

CERAMBYCIDAE

Three species of Cerambycidae were taken while feeding at flowers of *Larrea* at various localities in southern Arizona and New Mexico: *Aethecerinus latecinctus* Horn (May to July), *Plionoma suturalis* (LeConte) and *P. rubens* (Casey) (spring and fall). The first two have been recorded previously from flowering desert shrubs (Linsley, 1962). In the Tucson area we have taken *A. latecinctus* abundantly on blossoms of the desert ironwood (*Olneya tesota*).

A fourth species, *Perarthrus linsleyi* Knull, was found at *Larrea* flowers at Palm Springs, Riverside County, California in April.

CURCULIONIDAE

The large, flightless, largely nocturnal, desert weevils of the genus *Ophyrastes* are commonly found on *Larrea*, although their exact relationship to this plant remains to be determined. In Death Valley, California, we have taken *O. mortivagus* (Fall) from *Larrea* at Stovepipe Wells. At Palm Springs, Indio, and 18 miles west of Blythe,

Riverside County, we have found *O. varius* LeConte on *Larrea*, and Kissinger (1970) regards this plant as one of its most frequent hosts.¹ In southeastern Arizona we have taken three species from *Larrea*, *O. argentatus* LeConte (also found on *Larrea* by us at Palm Springs, Riverside County, California), *O. marmoratus* (Fall), and *O. nivosus* (Fall). This last is the most abundant *Larrea* species in the San Simon Valley and was common in the vicinity of Portal, Cochise County, Arizona and Lake Cienega, Hidalgo County, New Mexico. A second species found on *Larrea* at Portal is apparently near *O. dunnianus* (Casey). Kissinger records *O. dunnianus* from "*Larrea divaricata*" and *Viguiera stenoloba*. In New Mexico, *O. variabilis* (Pierce) was captured on *Larrea* at Deming, Luna County and 5 miles west of Elephant Butte, Sierra County.

In addition to our records, Kissinger lists *Larrea* as the only known host or one of several hosts, for *O. aridus* (Fall) (one record on creosote bush), *O. geminatus* (Horn) (mostly on shrubby composites in addition to *Larrea* and *Prosopis*), *O. mixtus* Kissinger (among the paratypes, 5 individuals from near Edom, California, *Larrea tridentata*, H. L. McKenzie), *O. speciosus* LeConte, *O. variabilis* (Pierce) (also on *Acacia* and *Prosopis*).

MISCELLANEOUS FAMILIES

Among the families of flower-visiting beetles collected at *Larrea*, only Melyridae, especially species of the genus *Trichochrus*, were present in numbers. *Lucaina discoidalis* Horn (Lycidae) was taken in the spring at Naco and Portal, Cochise County, Arizona; *Rhipiphorus sexdens* Linsley and MacSwain and *Rhipiphorus* sp. (Rhipiphoridae) at Naco; and *Eurygenius* sp. (Pedilidae) at Naco and Douglas, Cochise County, Arizona also during the spring of the year. Predaceous beetles were represented primarily by species of the genus *Collops* (Melyridae) and *Olla abdominalis* (Say). Leaf-feeding beetles were scarcely sampled. However, among those taken in Arizona were *Pachybrachys haematodes* Suffrian at Portal and Douglas and *P. desertus* Fall at Naco and Tombstone. *Diabrotica* spp. were usually not numerous and were confined to the flowers.

LEPIDOPTERA

Butterflies and moths could not be sampled conveniently during *Larrea*-bee surveys because of the lack of compatibility of sampling techniques. Among the former, the Lycaenidae were by far the most abundant at most sites in southeastern Arizona and western New

¹ Kissinger utilizes three different names for the U.S. species of *Larrea*, sometimes as though there were three species, undoubtedly following labels on the specimens.

Mexico. Moths were sometimes numerous about the flowers at dusk, before sunrise, on overcast days, and undoubtedly at night. Among these, geometrids were almost always represented, and some of these may have been host specific in the larval stage. Rindge (1959) records larvae of *Synglochis perumbraria* Hulst from southern California, southern Nevada, southern Utah, and across Arizona to western Texas. His map of the distribution of this species is extremely suggestive of that of *Larrea*, and he actually records two specimens from Tucson labelled "larva on *Covillea*." Two moths, *Heliodines metallicella* (Busck), described from Williams, Arizona (Busck, 1909), a diurnal species which we have taken at other flowers, particularly composites, and *Phalonia leguminiana* Busck, a nocturnal species which lives in seeds of Leguminosae (Busck, 1907), were taken from *Larrea* flowers near Yuma and Douglas, Arizona, respectively.

DIPTERA

Even though many representatives of this order are frequently encountered at *Larrea*, especially its flowers, there are relatively few species which have developed a dependent relationship or association with this plant.

CECIDOMYIIDAE

Among the plant-infesting Diptera associated with *Larrea*, the cecidomyiids are the most conspicuous since their galls ornament nearly every bush in many areas. Several types are abundant, but the most conspicuous is a globose, filamentous, woody, many-celled gall, one half to one inch in diameter, presumed to be formed by *Asphondylia auripila* Felt. This midge was reared from galls on *Larrea tridentata* collected at Tucson, Arizona, February 6, 1897 (Felt, 1908) and later he figured the gall (Felt, 1940). Another cecidomyiid gall which we have encountered is quite likely the one described but not named by Ballou (1925). The unknown midge is solitary but the galls occur in groups of two at the nodes near the ends of small twigs and resemble a group of leaves or a bud about ready to bloom. However, a variety of other galls are found in various parts of the range of *Larrea*, and as emphasized by Pritchard (1953) a study of the several midges attached to this host is much needed. In a preliminary survey, Szerlip (*in litt.*) recognized six distinct morphological types of *Larrea* galls.

ASILIDAE

The stems and branches of *Larrea* provide convenient perches for asilids which prey upon the bees, wasps and other insects that visit the flowers. In southeastern Arizona, these include *Mallophora faurix*

bromleyi Curran which perch high on vertical or nearly vertical branches and prey upon *Nomia mesillensis* Cockerell, *Megachile texana* Cresson, *Melissodes tristis* Cockerell and other medium sized *Larrea* visitors. *Mallophorina pulchra* Pritchard which perches in the lower part of the plant, frequently well inside, captures *Exomalopsis solani* Cockerell, *Dialictus* spp., *Perdita* spp. and other small bees. Large bees and wasps flying to *Larrea* flowers are preyed upon by *Diogmites grossus* Bromley and *Blepharepium secabilis* (Walker), but in general these flies prefer other habitats.

Other asilids present included three species of *Saropogon*, a genus of which more than twenty species are known from the southwestern United States (Wilcox, 1966). Except for *S. dispar* Coquillett, a notorious predator of honeybees (Alex, 1947), the feeding habits of these species appear to be relatively unknown. We found *S. bryanti* Wilcox on *Larrea* 11 miles south of Hermosillo, Sonora, Mexico, and *S. mohawki* Wilcox at Las Cruces, Dona Ana County, New Mexico, but neither were carrying prey when captured. However, at Las Cruces, *S. coquilletti* Back were particularly abundant about *Larrea* plants, and were feeding on both sexes of *Melissodes tristis* Cockerell, females of *Megachile texana* Cresson and no doubt other species.

When *Larrea*-feeding meloids were present, such as *Pyrota postica*, and various species of *Epicauta* and *Nemognatha*, they were fed upon by *Ospricerus abdominalis* (Say) (*O. ventralis* Macquart), which frequented *Larrea* plants in several localities in southern Arizona and New Mexico. The habitats and coloration of most of these robberflies have been discussed by Linsley (1960).

The only other species of Asilid captured with prey derived from *Larrea* was *Promachus giganteus* Hine which was feeding on the large coreid *Mozena arizonensis* Ruckes. Other species of this genus appear to prefer bees and wasps (Bromley, 1934; Alex, 1947; Fattig, 1945; Linsley, 1960).

Three species of *Efferia* were taken on *Larrea*, *E. benedicti* (Bromley) at Naco, Cochise County, Arizona, *E. frewingi* Wilcox, 10 miles south of Santa Ana, Sonora, Mexico, and *E. fugax* (Williston), 11 miles south of Hermosillo, Sonora, Mexico.

BOMBYLIIDAE

A variety of medium sized to large bee flies may be found at *Larrea* flowers in most localities, including *Anthrax xylocopae* Marston (1970), the parasite of the Arizona carpenter bee, *Xylocopa californica arizonensis* Cresson (Hurd, 1959). Others among our limited samples included: *Exoprosopa deris* Osten Sacken (Las Cruces, New Mexico), *Aphoebantus micropyga* Melander (Douglas, Arizona) and several unidentified species of *Villa*. The most regular, however, appear to be some of the very small species, some of which literally swarm about

the blossoms near sunrise, resembling small bees. In southeastern Arizona, the most abundant of these belonged to the genera *Pthiria*, of which one species each was taken at Portal, Douglas and Tombstone, Cochise County, Arizona, and *Geron*, with *G. albarius* Painter at Portal, *G. argutus* Painter at Douglas, and *G. grandis* Painter at Tombstone. In western Arizona and southern California, *Mithicomylia* were sometimes numerous. Melander (1961) who has recently revised the genus and described 126 new species and nine new varieties, records only one species, the widespread *M. rileyi* Coquillett as having been taken with some frequency at *Larrea* flowers. Most of the remaining species have been found on *Eriogonum*.

SYRPHIDAE

As would be expected, syrphid flies were conspicuous among visitors to the flowers of *Larrea*. The most widespread and abundant was *Eupeodes volucris* Osten Sacken, which at Palm Springs, Riverside County, California in March was present in such large numbers that they exceeded the abundant bees of the genus *Colletes* and provided a serious distraction to the sampling of bees. The species was also present in the spring at Yuma, Yuma County, Arizona, Tucson and vicinity, Pima County, Arizona, Benson, Cochise County, Arizona and Lordsburg, Hidalgo County, New Mexico. Other syrphids present at *Larrea* flowers included *Copestylum marginatum* (Say) (Douglas, Cochise County, Arizona), *C. haagii* Jaencke (Portal, Cochise County, Arizona), *Eristalis tenax* (Linnaeus) and *Metasyrphus* sp. (Tucson and vicinity, Pima County, Arizona) and *Allograpta obliqua* (Say) (Palm Springs, Riverside County, California).

TEPHRITIDAE

Tephritids were often numerous on *Larrea* but only four species were taken for identification: *Neotephritis inornata* (Coquillett) (Portal, Cochise County, Arizona), *Euaresta bellula* (Snow) (Naco and Douglas, Cochise County, Arizona), *Trupanea nigricornis* (Coquillett) (Douglas) and *Trupanea* sp. (23 miles west of Stanfield, Maricopa County, Arizona).

SARCOPHAGIDAE

As would be expected, sarcophagids were found at the flowers of *Larrea* in many areas. Only a few species were taken, as follows: *Blaesoxipha (Acanthodotheca)* spp. (Naco, Cochise County, Arizona), *Ravinia cherminieri* (Robineau-Desvoidy) (Tombstone, Cochise County, Arizona), and *Senotainia rubricentris* Macquart (Naco, Douglas, Portal and Cochise County, Arizona and Las Cruces, Dona Ana County, New Mexico).

TACHINIDAE

Tachinids, especially males, visited *Larrea* flowers in practically all of our study sites. The following species were taken among casual samples, mainly in southeastern Arizona and New Mexico: *Aravaipa atrophopoda* Townsend (Douglas, Cochise County, Arizona), *Archytas lateralis* (Macquart) Portal, Cochise County, Arizona), *Chaetogaedia desertorum* (Townsend) (Portal), *Chaetonodexodes vanderwulpi* (Townsend) (Douglas and Tombstone, Cochise County, Arizona), *Lespesia archippivora* (Riley) (18 mi. W. Stanfield, Maricopa County, Arizona and Douglas), *Muscopteryx chaetosula* Townsend (Las Cruces, New Mexico), *Peleteria valida* Curran (Portal), *Spalanzania hebes* (Fallen) (Deming, Luna County, New Mexico), and *Stomatomyia parvipalpis* (Wulp) (Douglas).

HYMENOPTERA

As noted elsewhere in this article, the bees associated with *Larrea* in the southwestern United States and adjacent Mexico have been discussed by us (Hurd and Linsley, 1975). Among the other members of this order commonly found in association with *Larrea* and especially about its flowers, are numerous aculeate wasps usually in quest of nectar. At times other wasps, such as braconids, chalcidoids and ichneumonids, were also encountered flying about the foliage, sleeping, searching for hosts or on occasion visiting the flowers for nectar.

CHRYSIDIDAE

Cuckoo wasps were seen on *Larrea* plants at many of our sampling stations, but their relations with the plant were not clear. Among the voucher specimens taken was the widespread *Holopyga ventralis* (Say), found at the flowers in May between 0930 and 1000 near Portal and between 1630 and 1700 at Douglas, Cochise County, Arizona. *Spintharosoma mesillae* (Cockerell) was also taken near Portal in May.

TIPHIDAE

Males of *Myzinum dubiosum* Cresson were fairly numerous about the flowers of *Larrea* in the morning during the summer at Las Cruces, Dona Ana County, New Mexico and at Deming, Luna County, New Mexico. A female taken at Las Cruces between 1730 and 1800 may be *Myzinum frontale* Cresson.

SCOLIIDAE

Scoliids were abundant during the summer at flowers of *Larrea* in most of our sampling sites in southern Arizona and New Mexico. Because pollen adheres to the legs and body hairs, some of the species

undoubtedly play a role in pollination (c.f. Cazier and Linsley, 1974). In August females and an occasional male of *Campsomeris tolteca* (Saussure) were present at *Larrea* flowers throughout the day (0830–1800) at Las Cruces, Dona Ana County, New Mexico and were also numerous near Portal, Cochise County, Arizona. Males were taken at the flowers in May, 18 miles west of Tucson, Pima County, Arizona. However, the most abundant and commonly encountered species was *Triscolia ardens* (Smith). In New Mexico this species was collected from *Larrea* flowers 5 miles west of Elephant Butte, Sierra County, Las Cruces, Dona Ana County, and Granite Pass, Hidalgo County. In Arizona, we found it near Portal, Douglas and Tombstone, Cochise County, and Tucson, Pima County. All collections were in July and August.

Trielis octomaculata (Say) was taken on the flowers in August at Las Cruces and Deming, New Mexico and Tucson, Arizona. *Scolia nobilitata fulviventris* Bartlett was present in small numbers at Granite Pass, Hidalgo County, New Mexico in July and was very abundant at Tucson, Arizona in August.

VESPIDAE

As would be expected, a variety of vespids visit *Larrea* flowers, but we rarely encountered them in numbers. *Eumenes bollii* Cresson was taken at Palm Springs, Riverside County, California in March and April, 18 miles west of Tucson, Pima County, Arizona in May, 4 miles west of Don Luis and 1 mile north of Portal, Cochise County, Arizona in May, at Lordsburg, Hidalgo County, New Mexico in August. This species was especially abundant at the Portal locality.

Another species encountered rather frequently during the spring was *Stenodynerus apache* Bohart, samples of which we took at Granite Pass, Hidalgo County, New Mexico, and near Portal and Douglas, Cochise County, Arizona. A related but unidentified species was captured at Tucson, Pima County, Arizona.

The remaining vespids in our samples included *Polistes fuscatus centralis* Hayward (Portal and Douglas, Cochise County, Arizona), *P. exclamans arizonensis* Snelling (Old Tucson, Pima County, Arizona), *Zethus guerreroi arizonensis* Bohart (Tombstone, Cochise County, Arizona), *Euodynerus hidalgo* (Saussure) (Douglas, Cochise County, Arizona), and related but undetermined species of *Euodynerus* (Saussure) (Portal and Douglas, Arizona), *Stenodynerus lixovestis* Bohart (7 miles southwest of Robles Junction on Highway 286, Pima County, Arizona), *Stenodynerus* sp. (Tucson Airport, Pima County, Arizona), *Parancistrocerus toltecus* (Saussure) (Portal and Douglas, Cochise County, Arizona) and *Pterocheilus pedicellatus* Bohart (Portal, Arizona).

SPHECIDAE

For convenience of discussion we have grouped under this family heading the several sphecoïd families represented by our material.

The most numerous sphecoïds at flowers of *Larrea* were species of the genus *Ammophila*. *Ammophila aberti* Haldeman was taken at Socorro, Socorro County, New Mexico in August, and at Portal and Douglas, Cochise County, California in May. *A. breviceps* Smith was present on *Larrea* at Lordsburg, Hidalgo County, New Mexico in May, *A. karenæ* Menke at Benson, Cochise County, Arizona in May, *A. novita* (Fernald) at a site 24.5 miles north of Yuma, Yuma County, Arizona in May, and *A. wrightii* (Cresson) at Douglas, Cochise County, Arizona in May. However, by far the most abundant *Ammophila* belong to the *pruinosa* complex. They were present at six of our sampling sites in New Mexico, eight sites in southern Arizona, and one site in southern California, on dates ranging from May to September. Other sphecoïds included *Sphex ashmeadi* (Fernald) (Las Cruces, Dona Ana County, New Mexico, in August), *S. lucae* Saussure (5 miles west of Elephant Butte, Sierra County, New Mexico, in August; Douglas, Cochise County, Arizona, in May; and Tucson, Pima County, Arizona, in August), *Podalonia argentifrons* (Cresson) (Chiriaco Summit, Riverside County, in May), *P. melæna* Murray (Portal and Douglas, Cochise County, Arizona, in May) and *Sceliphron caementarium* (Drury) (Douglas, Cochise County and 18 miles west of Tucson, Pima County, Arizona, in July and May, respectively).

Astatine sphecoïds were represented by *Astata bakeri* Parker (Portal, Cochise County, Arizona, in May); tachytines by *Tachysphex coquilleti* Rohwer (Portal, Cochise County, and Casa Grande, Pinal County, Arizona, in May) and undetermined species from Douglas, Cochise County, Arizona, and Lordsburg, Hidalgo County, New Mexico; psenines by *Ammopsen masoni* Krombein (Tucson Airport, Pima County, Arizona, in May); and gorytines by *Tanyoprymnus moneduloides* (Packard) (Douglas, Cochise County, Arizona, in July) and undetermined species of *Hoplisoides* (Portal and Douglas, Cochise County, Arizona, in May).

Among the bembicines, *Bembix U-scripta* (Fox) was the most numerous species visiting *Larrea* flowers at any one locality. At Las Cruces, Dona Ana County, on August 12 and 13, New Mexico, females were active from 0530–0630 and from 1830–1853 (sunset), although one was also taken at about 1800. Males, on the other hand were captured only between 1730 and 1830. Evans (1960) has recorded females hunting their dipteran prey in the dusk, around and after sunset, and males engaged in a "sun dance" both morning and evening. Cazier and Linsley (1974) reported males and females taking nectar from beneath the flowers of *Kallstroemia* in the morning as the flowers

began to unfurl. Apparently both sexes are bimodal in their diurnal flower-visiting habits.

Other bembicines included *Bembix sayi* Cresson (Portal, Cochise County, Arizona, in May), *Steniolia duplicata* Provancher (Yuma, Yuma County, Arizona, in April), *Stictiella pulchella* (Cresson) (Deming, Luna County, New Mexico, in August), *Glenostictia clypeata* (Gillaspay) (Portal, Cochise County, Arizona, females active between 0600 and 0700 in August, and Deming, Luna County, New Mexico, one female at approximately 0930) *G. gilva* Gillaspay (Douglas, Cochise County, Arizona, in May), and *G. scitula* (Fox) (Portal, Cochise County and 18 miles west of Tucson, Pima County, Arizona, in May).

Philanthus neomexicanus Strandtmann was the most numerous philanthine encountered on *Larrea*, 15 examples being represented in samples at Portal in May. Others included *P. gibbosus* (Fabricius) (Douglas, Cochise County, Arizona, in May), *P. multimaculatus* Cameron (Lordsburg, Hidalgo County, in May) and *Chlypeadon evansi* Bohart (Deming, Luna County and Lordsburg, Hidalgo County, New Mexico, in August and May, respectively).

Cercerines and crabronines were captured at *Larrea* flowers as follows: *Eucerceris arenaria* Scullen (18 miles west of Tucson, Pima County, Arizona and Chiriaco Summit, Riverside County, California, in May). *E. canaliculata* (Say) Douglas, Cochise County, Arizona, in May), *Cerceris macrosticta* Viereck and Cockerell (Las Cruces, Dona Ana County, New Mexico, in August), unidentified species of *Crabro* and *Ectemnius* (Yuma and Tucson, Arizona, respectively, in May and *Moniaecera asperata* (Fox) (18 miles west of Tucson, Pima County, Arizona, in May).

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